

is readily available in the Terai region and decomposes naturally, it can serve as a practical and environmentally friendly option for smallholder farmers. Therefore, farmers seeking maximum yield may prefer plastic mulch, whereas those aiming for a low-cost and sustainable production system may find rice straw mulch to be a suitable alternative.

4.5 Limitations and future research

The findings of this study should be interpreted in light of several limitations. The experiment was conducted at a single location during one growing season, and soil moisture, soil temperature, nutrient dynamics, and weed biomass were not measured directly. Consequently, the mechanisms responsible for the beneficial effects of mulching could not be verified experimentally.

Future research should evaluate these mulching materials across different locations and growing seasons to determine whether the observed responses remain consistent under varying environmental conditions. Measuring soil moisture, soil temperature, and nutrient availability would help explain the processes responsible for improved crop performance. In addition, economic analyses and assessments of the environmental impacts of plastic mulch would provide useful information for developing practical recommendations for onion growers in Nepal.

5 Conclusion

This study provides comprehensive evidence that mulching materials significantly influence the growth trajectory, bulb development, and marketable yield of onion under subtropical conditions in Chitwan, Nepal. Plastic mulch consistently maximized yield parameters, achieving a total fresh yield of 35.27 t/ha nearly double the control yield of 18.42 t/ha with the highest bulb weight (111.47 g), bulb diameter (7.08 cm), and stem diameter (1.41 cm). Rice straw mulch emerged as the strongest-performing organic alternative, particularly for plant height and leaf elongation, with a total yield of 29.54 t/ha representing a 60.4% improvement over the control.

Sawdust mulch demonstrated a specific advantage in promoting bulb elongation (5.19 cm), potentially valuable in markets favouring elongated bulb forms. Banana leaf mulch and the unmulched control consistently underperformed across all parameters. Given documented concerns regarding microplastic accumulation, soil contamination, and disposal challenges associated with long-term polyethylene mulch use, rice straw mulch is recommended as the preferred sustainable option for smallholder onion production in Nepal's Terai region. Where maximum productivity is the primary objective and plastic waste is responsibly managed, plastic mulch remains the most effective single intervention.

Future research should investigate the economic feasibility and cost-benefit ratios of mulching systems at different farm scales, long-term effects of organic mulches on soil health and microbial communities, performance across multiple onion varieties, and the potential of biodegradable plastic mulches as transitional alternatives to polyethylene.

Authors' contributions

BK conceived and designed the study, conducted the research, interpreted the results, and prepared the original manuscript. AG performed the data analysis, assisted with data interpretation, and critically reviewed the manuscript. SC managed the experimental field, supervised field operations, and collected the experimental data. All authors read and approved the final manuscript.

Conflict of Interest Disclosure

The authors affirm that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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